Summary of "Rural and Urban Outcomes After Hospitalization for Congestive Heart Failure in Alberta"

By Y. Jin, H. Quan, B. Cujec, and D. Johnson

Purpose

This study compared outcomes for patients hospitalized with heart failure in rural and metropolitan hospitals. The outcomes studied included in-hospital and one year mortality, hospitalization costs, length of hospital stay, and re-admission to hospital. Hospitals admitting patients with newly diagnosed heart failure were categorized into five groups on the basis of the total number of hospital discharges, geographic location, and special testing capability (specifically heart angiography).

Approach

Three Alberta administrative health service databases were used to obtain data between April 1, 1994 to March 31, 2000.

Key Findings

The following are key findings:

- During the six years of the study, there were 16,162 hospitalizations for newly diagnosed heart failure, which constituted fifty percent of all hospitalizations for heart failure.
- Hospitalizations for newly diagnosed heart failure were evenly distributed amongst the five hospitals types: rural with less than 200 cases (twenty-one percent), rural with 204 to 646 cases (twenty-one percent), regional (thirteen percent), metropolitan with angiography capability (twenty-four percent), and metropolitan without angiography capability (twenty-one percent).
- The hospitalization rate for newly diagnosed heart failure per 1,000 population was lower for residents of metropolitan regions (1.0) compared to residents of rural (1.7) and regional (2.0) health regions.
- Patients' other illness and heart failure severity were lower in those admitted to rural hospitals.
- Intensive care unit admissions and heart angiography were more frequent in patients admitted to metropolitan hospitals.
- After adjustment, the length of stay and mortality were similar amongst all hospital types.
- Adjusted hospital costs were about twenty-three percent ($900 Canadian) greater in metropolitan hospitals with heart angiography capability compared to all other hospital types.

Summary of "Rural and Urban Outcomes After Hospitalization for Congestive Heart Failure in Alberta"

By Y. Jin, H. Quan, B. Cujec, and D. Johnson

Conclusions

Higher admission rates in rural and regional hospitals make the appropriateness of hospital admission a target for quality improvement. The existing practice environment in metropolitan hospitals may limit hospital admissions. In metropolitan hospitals with heart angiography capability, the cost per admission was greater. Unless improved outcomes can be demonstrated, cost per admission is a target for quality improvement in metropolitan hospitals with heart angiography capability.

Outcomes for heart failure hospitalizations may be used as potential performance benchmarks in all hospitals that admit these patients. The utility of performance information may be important as both in-hospital mortality and length of hospital stay have decreased in patients admitted with heart failure suggesting that some outcomes are modifiable.

For More Information

Copies of the report are available from the

Alberta Centre for Health Services Utilization Research

- by contacting David Johnson by e-mail at cujecjohnson@shaw.ca
- at http://www.health.gov.ab.ca/system/key/Research/achsur_reports.html

Alberta Centre for Health Services Utilization Research

The Alberta Centre for Health Services Utilization Research is a joint initiative between the University of Alberta and the University of Calgary, funded by Alberta Health and Wellness. The Centre conducts studies of how health services are used and delivered to inform health policy development and management of health services delivery.

Release Date

November, 2003

Rural and Urban Outcomes After Hospitalization for Congestive Heart Failure in Alberta

By: Yan Jin, M.A. [1]

Hude Quan, M.D., Ph.D. [2]

Bibiana Cujec, M.D., FRCPC [3]

David Johnson, M.D., S.M., M.B.A.[4]

[1] Alberta Health and Wellness, Research and Evidence
[2] University of Calgary, Department of Community Health Services
[3] University of Alberta, Department of Medicine
[4] University of Saskatchewan, Department of Anaesthesia

November, 2003

Alberta Centre for Health Services Utilization Research

ACKNOWLEDGEMENT

The authors gratefully acknowledge the support provided by the Alberta Centre for Health Services Utilization Research, which conducts studies of how health services are used and delivered to inform health policy development and management of health service delivery. The Alberta Centre for Health Services Utilization Research is a joint initiative between the University of Alberta and the University of Calgary, funded by Alberta Health and Wellness. **The opinions and conclusions expressed in this paper are those of the authors and no endorsement by Alberta Health and Wellness is implied.**

For additional information, contact:

Dr. Bibiana Cujec
Division of Cardiology
University of Alberta
2C2.39 WMC
8440 – 112 Street
Edmonton, Alberta
T6G 2B7
Phone (780) 407-3601
Fax (780) 407-6452
E-mail: Bibiana.Cujec@ualberta.ca
ISBN: 0-7785-2401-9
http://www.health.gov.ab.ca/system/key/Research/achsur_reports.htm

TABLE OF CONTENTS

Summary 1
Introduction 2
Methods 3
Study Population: 3
Inclusion Criteria: 3
Exclusion Criteria: 3
Covariates: 4
Patient Characteristics: 4
Comorbidity of Disease: 4
Hospital Volume: 5
Congestive Heart Failure Outcomes: 5
Length of Stay: 5
Hospital Costs: 5
180-Days Readmission to Hospital: 6
Mortality: (one-year from day of admission) 6
Statistics 6
Results 7
Discussion 8
References 10
Figure Legends 14
Figure 1 – Age-Sex Adjusted for Ambulatory Congestive Heart Failure 14
Figure 2 – Age-Sex Related Rates for Hospitalized Congestive Heart Failure 15
Figure 3 – Age-Sex Adjusted Rates for Ambulatory Congestive Heart Failure 16
Figure 4 – Age-Sex Adjusted Rates: Hospitalized Patients 17
Table 1 – Patient Characteristics (Number and Percent) and Comorbidity for Hospitalized Congestive Heart Failure in Alberta During the Period April 1, 1994 to March 31, 2000 18
Table 2 – Use of Health Services and Selected Procedures (Number and Percent) for Hospitalized Congestive Heart Failure in Alberta During the Period April 1, 1994 to March 31, 2000 19
Table 3 – Unadjusted Outcomes for Patients Hospitalized Congestive Heart Failure in Alberta During the Period April 1, 1994 to March 31, 2000 20
Table 4 – Adjusted Outcomes With Ninety-Five Percent Confidence Interval for Hospitalized Congestive Heart Failure in Alberta During the Period April 1, 1994 to March 31, 2000 21
Table 5 – Unadjusted Outcomes for Patients Hospitalized Congestive Heart Failure in Alberta During the Period April 1, 1994 to March 31, 2000 in each of the Seventeen Alberta Regions (Where Hospitalization Occurred) 22

Table 6 – Unadjusted Outcomes for Patients Hospitalized Congestive Heart Failure in Alberta During the Period April 1, 1994 to March 31, 2000 in Each of the Seventeen Alberta Regions (Where Patient Resided)....23
Biographies **24**
Yan Jin, M.A. 24
Hude Quan, M.D., Ph.D. 25
Bibiana Cujec, M.D., FRCPC 26
David Johnson, M.D., S.M., M.B.A. 27

SUMMARY

We compared the hospitalization rate, duration, cost, and mortality for newly diagnosed congestive heart failure in patients admitted to rural and metropolitan hospitals in one Canadian province using administrative data from April 1, 1994 to March 31, 2000.

Hospitalizations (16,162) for newly diagnosed congestive heart failure constituted fifty percent of all hospitalizations for congestive heart failure. Hospitals were distributed as follows: rural with less than 200 cases (twenty-one percent of hospitalizations), rural with 204 to 646 cases (twenty-one percent of hospitalizations), regional (thirteen percent of hospitalizations), metropolitan with angiography capability (twenty-four percent of hospitalizations), and metropolitan without angiography capability (twenty-one percent of hospitalizations). The hospitalization rate per 1,000 population was lower for residents of metropolitan regions (1.01; ninety-five percent CI 0.97, 1.05) compared to residents of rural (1.70; ninety-five percent CI 1.65, 1.75) and regional (1.95; ninety-five percent CI 1.90, 2.00) health regions. Patient comorbidity and severity scores were lower in rural hospitals. Special care unit admissions and cardiac catheterizations were more frequent in patients admitted to metropolitan hospitals. After adjustment, the length of stay and mortality were similar amongst all hospital types. Adjusted hospital total costs were about twenty-three percent ($900 Canadian) greater in metropolitan hospitals with angiography capability compared to rural hospitals.

We concluded that hospital admission rates for newly diagnosed congestive heart failure were lower for metropolitan residents compared to non-metropolitan residents. Cost per admission was greatest in metropolitan hospitals with angiography capability compared to other hospital types.

INTRODUCTION

Congestive heart failure is the most common diagnosis for hospital admission in the United States [1] and other industrialized countries [2-6]. The rate of admission to hospital for congestive heart failure has increased to such an extent that the label "epidemic" has been used [2, 7]. The increase in congestive heart failure may be related to demographic changes in an aging population or related to enhanced survival from acute ischemic heart disease (the most common cause of congestive heart failure) [1, 8]. Mortality from congestive heart failure varies with age, comorbidity, race, residence and the type of care received [7, 9-14]. Process of care for congestive heart failure also varies by location of the admitting hospital (rural or urban) [15, 16].

To our knowledge there are no population-based studies about the variation in outcomes for congestive heart failure patients comparing rural and urban hospitals. Markers for outcomes of care include in-hospital mortality but as well longer-term mortality, hospitalization costs, length of hospital stay, and readmission to hospital. We hypothesized that outcomes after hospitalization for newly diagnosed congestive heart failure varied by the type of admitting hospital. Hospitals admitting patients with newly diagnosed congestive heart failure were categorized into five groups on the basis of the total number of hospital discharges, geographic location, and angiography capability. Outcomes for congestive heart failure hospitalizations may be used as potential performance benchmarks in all hospitals that admit these patients [17, 18]. The utility of performance information may be important as both in-hospital mortality and length of hospital stay have decreased over the last decade suggesting that some outcomes are modifiable [13, 14].

METHODS

Three administrative health service databases were used and the analysis was done within the protected environment of Alberta Health and Wellness, which is governed by provincial legislative guidelines on the confidentiality of health information:

1. Canadian Institute for Health Information's (CIHI) Inpatient Discharge Abstract Database (DAD) for the province of Alberta for fiscal years 1992/1993 to 1999/2000,
2. Alberta Health Insurance Plan Registry File for fiscal years 1994/1995 to 1999/2000, and
3. Alberta Physician Claims Assessment System Database for 1992/1993 to 1999/2000.

Study Population:

Inclusion Criteria:

1. Congestive heart failure (CHF) was defined using the fifteenth International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM 428.x, 398.91, 402.x 1, 404.x greater than 0, 514.x, 518.4, 425.9) in the most responsible diagnosis field of the hospital abstract [19, 20].

Exclusion Criteria:

1. Not an Alberta resident,
2. Age < 20,
3. Not admitted to an Alberta acute care facility,
4. Hospitalization for congestive heart failure (as the most responsible diagnosis) during the two years prior to index encounter,
5. Previous internal medicine specialist or related sub-specialist consultation claim as an ambulatory patient for congestive heart failure (defined as for hospitalizations) as the most responsible diagnosis (CPX 03.x) [21] during the two years prior to index encounter, and
6. Duplicate hospital discharge within the five study years (one new diagnosis of congestive heart failure per patient).

Covariates:

Patient Characteristics:

1. Age (20 to 49, 50 to 64, 65 to 75, 75 to 84, and 85 and over),
2. Sex (female versus male),
3. Year of congestive heart failure hospital discharge,
4. Alberta regions of residence at time of study (seventeen health regions) were grouped into two metropolitan regions (Calgary and Edmonton), five regions with a designated regional referral hospital that provided secondary and some tertiary care, and all others in one rural region, and
5. Export (admission to a hospital located in a region not within region of residence).

Comorbidity of Disease:

The seventeen comorbidities that constitutes the Charlson index [22, 23] were defined using Deyo's coding algorithm and the fifteen supplemental diagnosis fields in the CIHI DAD hospital abstract. The Charlson comorbidities were aggregated into none, one, and two or more of the individual conditions. Polanczyk's comorbidities [24] were defined as:

1. Anemia (ICD-9-CM 280.xx to 285.xx),
2. Hyponatremia and other electrolyte disturbance (ICD-9-CM 276.x),
3. Coronary artery disease (ICD-9-CM 411.xx, 413.xx, 414.xx),
4. Hypertension (ICD-9-CM 401.xx to 405.xx),
5. Valvular heart disease (ICD-9-CM 394.xx to 398. xx, 424.xx),
6. Ventricular arrhythmia (ICD-9-CM 427.4x, 427.5x, 427.6x), and
7. Hypotension and shock (ICD-9-CM 458.xx, 785.5x).

We also recorded:

1. Transferred to another acute care hospital (all outcomes attributed to first hospital contact),
2. Special care unit admission (hospital defined), and
3. Cardiac catheterization (defined below). A severity score was defined by Polanczyk [24] and assigned to each patient using the following weighting method: one point per decade of age greater than forty years plus two points for each of transferred admission, cerebral vascular disease, chronic obstructive lung disease, hyponatremia, other electrolyte disturbance, metastatic disease) plus four points for moderate to severe renal disease plus six points for ventricular arrhythmia, mild liver disease, or malignancy) plus thirteen points for hypotension or shock.

Health services associated congestive heart failure in the year following initial diagnosis:

1. Cardiac catheterization (Physician claims CPX 48.92A, 48.98A, 48.98B, 49.96A, 49.96B),
2. Percutaneous transluminal coronary angioplasty / stenting (Physician claim CPX 51.59 C), and
3. Coronary artery bypass surgery (Physician claims CPX 48.0 A, 48.12, 48.12A, 48.13, 48.13A, 48.14, 48.14A, 48.15A, 48.15B, 48.15C, 48.15D, 48.15E, 48.15F, 48.15G, 48.15H, 48.19A).

Hospital Volume:

At the time of this study, all hospitals in Alberta were administered by an autonomous regional board in each of the seventeen health regions. Nearly all of the three million residents of Alberta enrolled in the public health care insurance plan reside in one of the seventeen health regions. Alberta hospitals admitting congestive heart failure patients were categorized into five groups on the basis of the total number of congestive heart failure separations between April 1, 1994 until March 31, 2000 and geographic location.

1. Rural hospitals with low volume (n = seventy-seven) with less than 200 cases,
2. Rural hospitals with high volume (n = twenty-five) with 204 to 646 cases,
3. Regional hospitals (n = five) located in one of the five non-metropolitan regional health care cities had 238 to 646 cases,
4. Metropolitan hospitals (n = six) located in the metropolitan health region of Calgary and Edmonton without angiography capability had 327 to 2,199 cases, and
5. Metropolitan hospitals (n = three) located in the metropolitan health regions of Calgary and Edmonton with angiography capability had 1,793 to 2,700 cases.

Congestive Heart Failure Outcomes:

Length of Stay:

Length of stay was calculated as days between discharge and admission date. Transfers (defined as readmission to different hospitals within one day) were attributed to the index admission and cumulative hospital length of stay calculated for an episode of care. Length of stay in regressions are restricted to those discharged alive.

Hospital Costs:

Inpatient hospital costs were calculated per resource group number (RGN – an Alberta refinement of Diagnosis Related Groups) using methodology described by an Alberta Provincial Costing Project and in accordance with Provincial and National Management Information Systems guidelines [25, 26]. Total costs combined all direct and indirect costs associated with an inpatient hospitalization from the time a patient was admitted to the

hospital to the time they were discharged. All costs per RGN were estimated using 1998/1999 costs and assumed similar for all the study years. The quality of the data reporting of costs in Alberta has been highly ranked by the Canadian Institutes for Health Information [27]. As such, the methodological issues that arise around collection of cost data in the United States [28] due to the use of prices rather than costs do not arise in this analysis.

180-Days Readmission to Hospital:

First readmission to any acute care hospital within 180 days for those alive at hospital discharge for any diagnosis.

Mortality: (one-year from day of admission)

Vital statistics declaration of death certificates were merged with the Alberta Health and Wellness Premium Registry databank in order to determine de-registration from the plan. One-year mortality were deaths after date of admission but excluded in-hospital deaths.

STATISTICS

Age-sex standardized rates and the ninety-nine percent confidence intervals were calculated for newly diagnosed hospitalized and ambulatory congestive heart failure. The indirect standardization method was used with overall annual provincial age-sex rates (twenty to sixty-four years old, ten-year increment afterwards up to eighty-four years old, eighty-five and over for each sex) as standard rates.

The specific factor of interest for statistical analysis was hospital type. Bivariate and multivariate comparisons were done by chi-square and differences in variance as appropriate. Covariates used for all multiple regression adjustments included age, sex, year of congestive heart failure hospital discharge, metropolitan or non-metropolitan region of residence, exported case, comorbidity (anemia, coronary artery disease, hypertension, valvular heart disease), transfer to another acute care hospital, admission to special care unit, severity of illness score, comorbidity score, and cardiac catheterizations. The expected outcomes used in calculating mortality and readmission rates were derived using logistic regression. The adjusted outcome rates for hospitals were calculated by multiplying the observed / expected ratio for each hospital group by the overall crude (i.e. observed) outcome rate. Adjusted length of stay and hospital costs per hospitalization were calculated using multiple regression and least-square means. In the analysis of length of stay, hospital costs, and readmissions; in-hospital deaths were excluded. Modeling used SAS (Version 6.12) [SAS Institute Inc. Cary, NC 2000] and significance was defined as $p < 0.05$.

RESULTS

During the six years of the study, there were 16,162 hospitalizations for newly diagnosed congestive heart failure. These incident hospitalization represent fifty percent of the total hospital admission for congestive heart failure (n = 32,139) during the study period. The total number of hospitalizations not classified as new diagnosis using the exclusion criteria was 8,085. As shown in Table 1, the hospitalizations were relatively uniformly distributed amongst the five hospitals types: rural with less than 200 cases (twenty-one percent), rural with 204 to 646 cases (twenty-one percent), regional (thirteen percent), metropolitan without angiography capability (twenty-four percent), and metropolitan with angiography capability (twenty-one percent). The cohort of patients with congestive heart failure was predominately elderly (mean age = 75.9 years) compared to the mean age of forty-four years in the 1998/1999 population of adults in Alberta. Older age and proportion of females was higher in rural hospitals. Overall 65.5 percent in the cohort had one or more than one comorbidity. The distribution of patient comorbidity and congestive heart failure severity scores were lower in rural hospitals. Less than two percent of hospitalizations for metropolitan region patients occurred in non-metropolitan hospitals whereas nearly ten percent of metropolitan hospital admissions were for non-metropolitan residents. The average number of hospital beds per 1,000 population during the study period was 2.4, 2.5, and 2.3 in rural, regional, and metropolitan regions. No more than two percent of patients admitted to any of the five hospital types were transferred to another hospital (Table 2). In-hospital (special care unit admissions and cardiac catheterizations) and therapy in the subsequent one-year (cardiac catheterizations and reperfusion) were more frequently utilized in patients admitted to metropolitan hospitals.

The population hospitalization rates for newly diagnosed congestive heart failure in each of the three types of health regions is shown in Figure 1. The adjusted hospitalization rate for newly diagnosed congestive heart failure per 1,000 population was lower for residents of metropolitan regions (1.01; ninety-nine percent CI 0.97, 1.05) compared to residents of regional (1.70; ninety-nine percent CI 1.65, 1.75) and rural (1.95; ninety-nine percent CI 1.90, 2.00) health regions. The adjusted new ambulatory diagnosis rate for congestive heart failure per 1,000 population was higher for residents of metropolitan regions (0.81; ninety-nine percent CI 0.79, 0.84) compared to residents of rural (0.71; ninety-nine percent CI 0.66, 0.75) health regions. Crude and adjusted outcomes for congestive heart failure hospital admissions are shown in Tables 3 and 4. After adjustment, the increased crude length of stay and mortality in regional and metropolitan hospitals were now similar in all hospital types. Crude and adjusted 180-day readmission rates were higher in regional and rural hospitals compared to metropolitan hospitals. Crude and adjusted hospital costs were greatest in metropolitan hospitals with angiography capability.

DISCUSSION

Congestive heart failure was a common reason for hospital admission in Alberta and elsewhere [29]. The annual incident hospitalization rate was about 1.1 cases per 1,000 or about 3,200 annual incident hospital discharges. The incidence of newly diagnosed congestive heart failure hospitalization varied between health regions in Alberta with higher rates in rural regions and lower rates in metropolitan regions. The incidence of ambulatory non-hospitalized congestive heart failure diagnosed by internal medicine specialists and related sub-specialists varied between health regions in Alberta; more in metropolitan regions and less in rural regions. The all cause in-hospital mortality rate was 9.2 percent and one-year mortality rate was 23.7 percent, which was similar to other studies [29]. Outcomes for patients in registry data bases and longitudinal cohort studies were much worse than those reported in clinical trials that only enrolled selected patients [30, 31]. After adjusting for severity, comorbidity, and demographic factors, length of hospital stay and mortality were similar between all types of hospital. After adjustment, re-hospitalizations were more frequent in rural / regional hospitals and hospital costs were greater in metropolitan hospitals with angiography capability. Utilization analysis may be helpful in targeting quality improvement initiatives specific to the need of different hospitals and health regions. In this study, rural hospitals in Alberta admitted patients with less comorbidty, lower severity of illness, and lower crude in-hospital mortality. The higher readmission rates in rural and regional hospitals were also consistent the increased utilization of these hospitals. The existing practice environment in Alberta rural regions and some health regions with a regional hospital make the appropriateness of hospital admission a target for quality improvement. The existing practice environment in Alberta metropolitan hospitals may limit hospital admissions. For example, the distribution of specialists to metropolitan regions may artificially decrease the number of ambulatory diagnosis by specialists and increase hospital admissions in rural regions. A lower rural rate of newly diagnosed congestive heart failure in ambulatory patients may suggest that some patients hospitalized in rural hospitals may not have been hospitalized in metropolitan hospitals and alternatively treated as ambulatory patients although the variation in ambulatory diagnosis was much less than that noted for hospitalizations. Hospital rate differences between rural and metropolitan regions may also be impacted by factors not found within-hospital abstracts such as patient and physician preferences, economic status, or presence of other services such as home care.

The existing practice environment in metropolitan hospitals with angiography capability make the cost per admission a more likely target for quality improvement [32]. The higher cost per patient in-hospitals with angiography capability did not translate into an improved in-hospital or one-year mortality difference between rural and metropolitan hospitals even after adjustment for comorbidity and case severity. Differential rates of cardiac catheterizations have been demonstrated for myocardial infarction patients

dependent upon the type of admitting hospital [33]. In Alberta, quality improvement targets in patients with congestive heart failure for metropolitan hospitals with angiography capability should focus upon the indications for cardiac catheterization [34], and derrived benefit (i.e. mortality, quality of life).

This study does not directly specify what practice patterns among rural, regional, and metropolitan hospitals might lead to variation in admissions or greater utilization of specific health services. The number of hospital beds per 1,000 population was not dramatically different amongst regions. Comparative bed counts may not reflect the pressures exerted to fill these beds. Metropolitan hospital may have greater pressures exerted because beds were used for cases referred from rural regions or referred for medical services not provided in non-tertiary or non-teaching hospitals. Small area variation studies such as ours are plagued with the unanswerable question "which rate is right?" [35]. In our study, regional differences in-hospital discharge rates existed. There exists a limited ability in Canada to deny appropriate admissions – only delay is possible. Patients inappropriately denied initial hospital admission would likely return and be admitted at a later date. As the Alberta health care system is comprehensive, we did not 'lose' patients to other jurisdictions or hospital systems. Even death after the initial hospital denial is not a plausible explanation for lower admission rates. Seventy-five percent of Canadian patients die in-hospital [36] so that a denied hospitalization may have been delayed but not avoided. The importance of rate differences and the potential impact upon care requires clinical judgement. Utilization analysis helps target where the probability of potential change is greater because variation is greater. However, an overall provincial rate may still be uniformly too high or too low even though the variation was small.

This study has several limitations. Population-based administrative database research is highly generalizable although limited in clinical details. We attempted to adjust for case severity and comorbidity although these data may not have captured all-important variation. The diagnosis of congestive heart failure from hospital discharge data may underestimate the true prevalence of this disease [37, 38]. We constructed an episode of care by attributing readmissions within the first day of discharge back to the original index admission. Our length of stay was attributed to the presenting hospital rather than all hospitals in which care could have been rendered. Our cost data did not include those costs associated with ambulatory care.

REFERENCES

1. Haldeman, G.A., Croft, J.B., Giles, W.H., and Rashidee, A., Hospitalization of Patients With Heart Failure: National Hospital Discharge Survey, 1985 to 1995, American Heart Journal, 1999; 137: 352-60

2. Murdoch, D.R., Love, M.P., Robb, S.D., McDonagh, T.A., Davie, A.P., Ford, I., Capewell, S., Morrison, C.E., and McMurray, J.J., Importance of Heart Failure as a Cause of Death, Changing Contribution to Overall Mortality and Coronary Heart Disease Mortality in Scotland 1979-1992, European Heart Journal, 1998; 19: 1,829-35

3. Ryden-Bergsten, T., and Andersson, F., The Health Care Costs of Heart Failure in Sweden, Journal of Internal Medicine, 1999; 246: 275-84

4. Mejhert, M., Persson, H., Edner, M., and Kahan, T., Epidemiology of Heart Failure in Sweden--A National Survey, European Journal of Heart Failure, 2001; 3: 97-103

5. Owen, A., and Cox, S., Diagnosis of Heart Failure in Elderly Patients in Primary Care, European Journal of Heart Failure, 2001; 3: 79-81

6. Stewart, S., MacIntyre, K., MacLeod, M.M., Bailey, A.E., Capewell, S., and McMurray, J.J., Trends in-hospitalization for Heart Failure in Scotland, 1990-1996, An Epidemic That has Reached its Peak? European Heart Journal, 2001; 22 (3): 209-17

7. Philbin, E.F., and DiSalvo, T.G., Prediction of Hospital Readmission for Heart Failure: Development of a Simple Risk Score Based on Administrative Data, Journal of the American College of Cardiology, 1999; 33: 1,560-6

8. Ali, A.S., Rybicki, B.A., Alam, M., Wulbrecht, N., Richer-Cornish, K., Khaja, F., Sabbah, H.N., and Goldstein, S., Clinical Predictors of Heart Failure in Patients With First Acute Myocardial Infarction, American Heart Journal, 1999; 138: 1,133-9

9. Croft, J.B., Giles, W.H., Pollard, R.A., Keenan, N.L., Casper, M.L., and Anda, R.F., Heart Failure Survival Among Older Adults in the United States: A Poor Prognosis for an Emerging Epidemic in the Medicare Population, Archives of Internal Medicine, 1999; 159: 505-10

10. Vaur, L., Danchin, N., Genes, N., Dubroca, I., Etienne, S., Ferrieres, J., and Cambou, J.P., Epidemiology of Myocardial Infarction in France: Therapeutic and Prognostic Implications of Heart Failure During the Acute Phase, American Heart Journal, 1999; 137: 49-58

11. Herlitz, J., Karlson, B.W., and Bang, A., Mode and Risk Indicators for Death During Five Year Follow-up of Survivors of Acute Myocardial Infarction, An Evaluation With Particular Emphasis on Congestive Heart Failure and Age, Coronary Artery Disease, 1997; 8: 455-62

12. Ashton, C.M., Petersen, N.J., Souchek, J., Menke, T.J., Pietz, K., Yu, H.J., and Wray, N.P., Rates of Health Services Utilization and Survival in Patients With Heart Failure in the Department of Veterans Affairs Medical Care System, American Journal of Medical Quality, 1999; 14: 55-63

13. Polanczyk, C.A., Rohde, L.E., Dec, G.W., and DiSalvo, T., Ten-Year Trends in-hospital Care for Congestive Heart Failure: Improved Outcomes and Increased use of Resources, Archives of Internal Medicine, 2000; 160: 325-32

14. Ni, H, Nauman, D.J., and Hershberger, R.E., Analysis of Trends in Hospitalizations for Heart Failure, Journal of Cardiac Failure, 1999; 5: 79-84

15. Taubert, G., Bergmeier, C., Andresen, H., Senges, J., and Potratz, J., Clinical Profile and Management of Heart Failure: Rural Community Hospital vs. Metropolitan Heart Centre, European Journal of Heart Failure, 2001; 3: 611-7

16. Philbin, E.F., Rocco, T.A., Jr., Lindenmuth, N.W., Ulrich, K., and Jenkins, P.L., Clinical Outcomes in Heart Failure: Report From a Community Hospital-Based Registry. American Journal of Medicine, 1999; 107: 549-55

17. Rosenthal, G.E., Baker, D.W., Norris, D.G., Way, L.E., Harper, D.L., and Snow, R.J., Relationships Between in-Hospital and 30-day Standardized Hospital Mortality: Implications for Profiling Hospitals. Health Services Research, 2000; 34: 1, 449-68

18. Ashton, C.M., Bozkurt, B., Colucci, W.B., Kiefe, C.I., Mann, D.L., Massie, B.M., Slawsky, M.T., Tierney, W.M., West, J.A., Whellan, D.J., and Wray, N.P., Veterans Affairs Quality Enhancement Research Initiative in Chronic Heart Failure, Medical Care, 2000; 38 (6 Suppl 1): I26-37

19. Wolinsky, F.D., Overhage, J.M., Stump, T.E., Lubitz, R.M., and Smith, D.M., The Risk of Hospitalization for Congestive Heart Failure Among Older Adults. Medical Care, 1997; 35: 1,031-43

20. Goff, D.C., Jr., Pandey, D.K., Chan, F.A., Ortiz, C., and Nichaman, M.Z., Congestive Heart Failure in the United States: is There More Than Meets the ICD Code? The Corpus Christi Heart Project, Archives of Internal Medicine, 2000; 160: 197-202

21. Canadian Classification of Diagnostic, Theraputic, and Surgical Procedures Second Printing Statistics Canada Health Division Nosology Reference Centre Minister of Supply and Services, 1986, Ottawa, Canada

22. Deyo, R.A., Cherkin, D.C., and Ciol, M.A., Adapting a Clinical Comorbidity Index for use With ICD-9-CM Administrative Databases, Journal of Clinical Epidemiology, 1992; 45: 613-9

23. Romano, P.S., Roos, L.L., and Jollis, J.G., Adapting a Clinical Comorbidity Index for use With ICD-9-CM Administrative Data: Differing Perspectives, Journal of Clinical Epidemiology, 1993; 46: 1,075-9

24. Polanczyk, C.A., Rohde, L.E., Philbin, E.A., and DiSalvo, T.G., A New Casemix Adjustment Index for Hospital Mortality Among Patients With Congestive Heart Failure, Medical Care, 1998; 36 (10): 1,489-99

25. Regional Health Authority Global Funding Manual, 2000-2001, in Funding Health Resourcing Branch, Alberta Health and Wellness, March, 2000, Edmonton, Alberta

26. Guidelines for Management Information Systems in Canadian Health Service Organizations, Canadian Institute for Health Information, 1999, Ottawa, Ontario

27. McKillop, I., Pink, G.H., and Johnson, L.M., The Financial Management of Acute Care in Canada: A Review of Funding, Performance Monitoring and Reporting Practices Canadian Institute for Health Information, 2001, Ottawa, Ontario p 83

28. Magnus, S.A., and Smith, D.G., Better Medicare Cost Report Data are Needed to Help Hospitals Benchmark Costs and Performance Health Care Manage Rev, 2000; 25: 65-76

29. Alexander, M., Grumbach, K., Remy, L., Rowell, R., and Massie, B.M., Congestive Heart Failure Hospitalizations and Survival California: Patterns according to Race / Ethnicity, Am Heart J, 1999; 137: 919-27

30. Dominguez, L.J., Parrinello, G., Amato, P., and Licata, G., Trends of Congestive Heart Failure Epidemiology: Contrast With Clinical Trial Results Cardiologia, 1999; 44: 801-8

31. Krumholz, H.M., Amatruda, J., Smith, G.L., Mattera, J.A., Roumanis, S.A., Radford, M.J., Crombie, P., and Vaccarino, V., Randomized Trial of an Education and Support Intervention to Prevent Readmission of Patients With Heart Failure, Journal of the American College of Cardiology, 2002; 39: 83-90

32. Philbin, E.F., McCullough, P.A., Dec, G.W., and DiSalvo, T.G., Length of Stay and Procedure Utilization are the Major Determinants of Hospital Charges for Heart Failure, Clinical Cardiology. 2001; 24: 56-62

33. Cox, J.L., Chen, E., and Naylor, C.D., Revascularization After Acute Myocardial Infarction: Impact of Hospital Teaching Status and On-Site Invasive Facilities. Journal of General Internal Medicine, 1994; 9: 674-8

34. Pinsky, J.L., Kannel, W.B., and Levy, D., The Epidemiology of Heart Failure: the Framingham Study, Journal of the American College of Cardiology, 1993; 22(4 Suppl A): 6A-13A

35. Wennberg, J., Which Rate is Right? New England Journal of Medicine, 1986; 314: 310-1

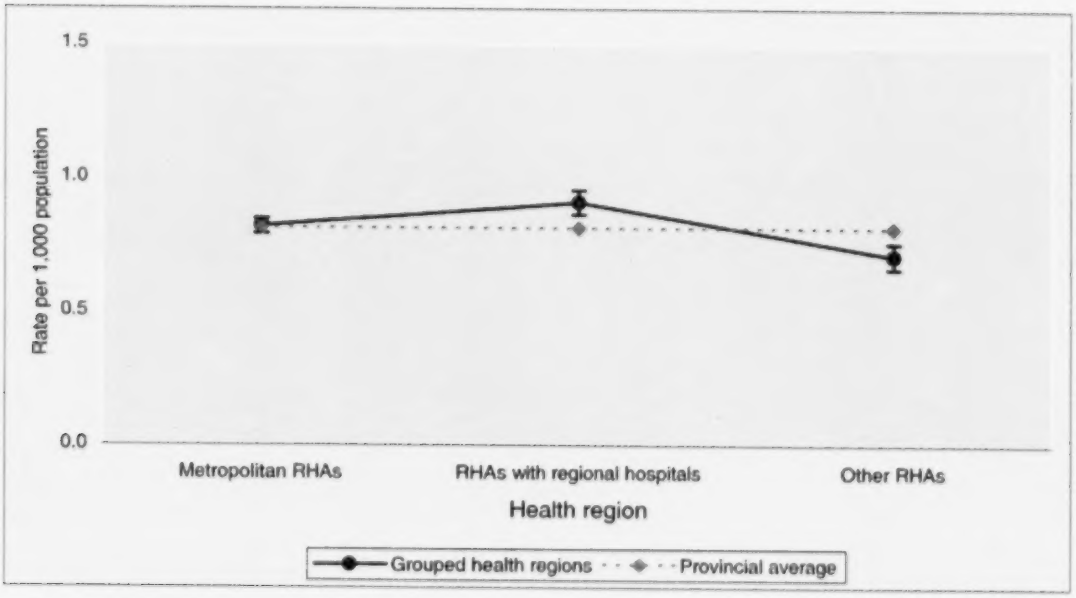
36. Heyland, D.K., Lavery, J.V., Tranmer, J., Shoett, S.E.D., and Taylor, S.J., For the Queen's/KGH End of Life Research Working Group, Dying in Canada: Is it an Institutionalized, Technologically Supported Experience? J Palliative Care, 2000; 16: S10-S16

37. Morgan, A., Smith, H., Simpson, I., Liddiard, G.S., Rapheal, H, Pickering, R.M., and Mant, D., Prevalence and Clinical Characteristics of Left Ventricular Dysfunction Among Elderly Patients in General Practice Setting: A Cross Sectional Survey, BMJ, 1999; 318: 368-72

38. Akosah, K.O., Moncher, K., Schaper, A., Havlik, P., and Devine, S., Chronic Heart Failure in the Community: Missed Diagnosis and Missed Opportunities, Journal of Cardiac Failure, 2001; 7: 232-8

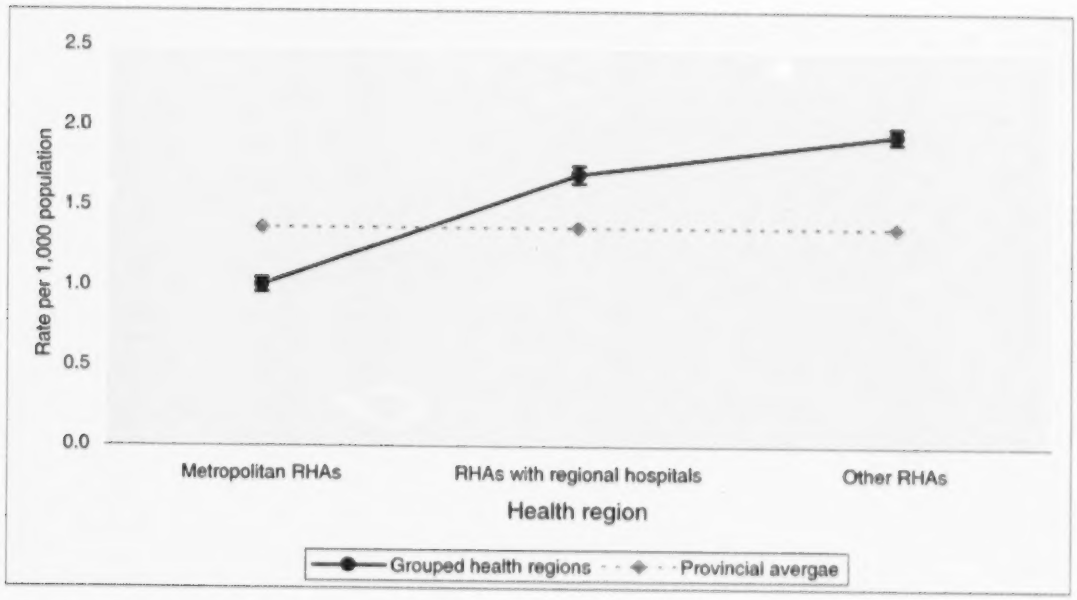
FIGURE LEGENDS

Figure 1 – Age-Sex Adjusted for Ambulatory Congestive Heart Failure



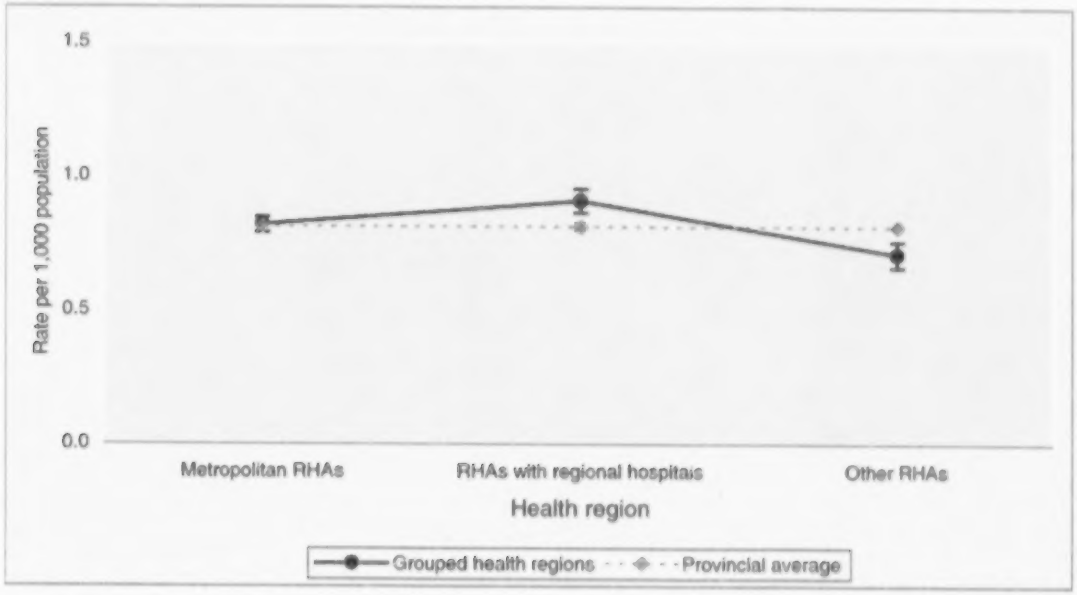
Age-sex adjusted hospital discharge rates per 1,000 for newly diagnosed congestive heart failure in metropolitan, regional and rural health regions during 1994/1995 to 1999/2000. Bars indicate ninety-nine percent confidence interval and dashed line is provincial average.

Figure 2 – Age-Sex Related Rates for Hospitalized Congestive Heart Failure



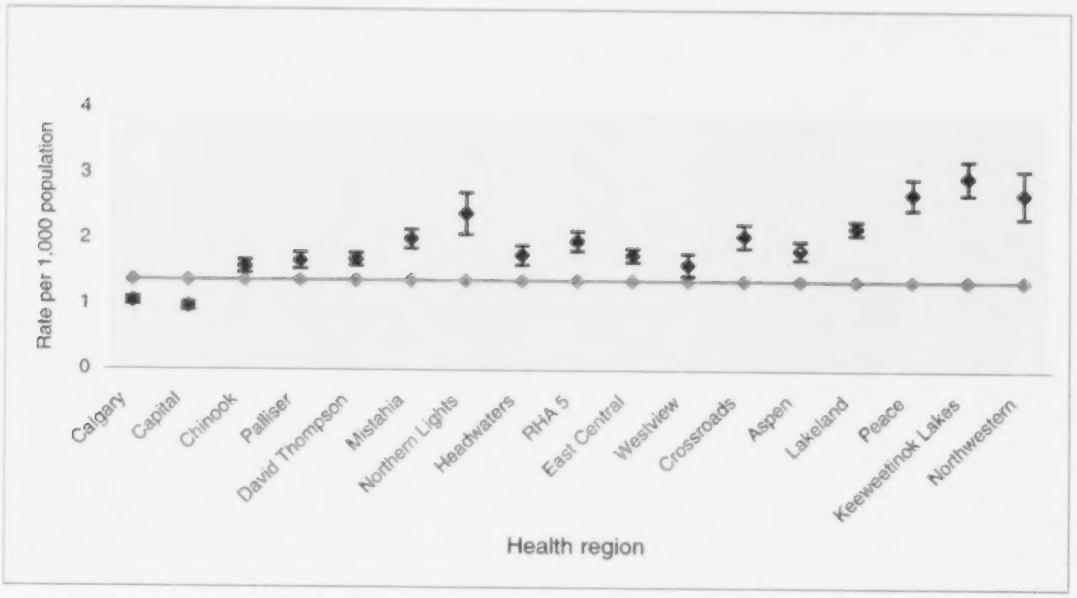
Age-sex adjusted rates per 1,000 for newly diagnosed ambulatory congestive heart failure in metropolitan, regional and rural health regions during 1994/1995 to 1999/2000. Bars indicate ninety-nine percent confidence interval and dashed line is provincial average.

Figure 3 – Age-Sex Adjusted Rates for Ambulatory Congestive Heart Failure



Age-sex adjusted hospital discharge rates per 1,000 for newly diagnosed congestive heart failure in the seventeen Alberta health regions during 1994/1995 to 1999/2000. Bars indicate ninety-nine percent confidence interval and dashed line is provincial average.

Figure 4 – Age-Sex Adjusted Rates: Hospitalized Patients



Age-sex adjusted rates per 1,000 for newly diagnosed ambulatory congestive heart failure in the seventeen Alberta health regions during 1994/1995 to 1999/2000. Bars indicate ninety-nine percent confidence interval and dashed line is provincial average

Table 1 – Patient Characteristics (Number and Percent) and Comorbidity for Hospitalized Congestive Heart Failure in Alberta During the Period April 1, 1994 to March 31, 2000

	Rural hospitals less than 200 cases n = 3,444	Rural hospitals 204 to 646 cases n = 3,363	Regional hospitals n.= 2,161	Metropolitan hospitals without angiography n = 3,384	Metropolitan hospitals with angiography n = 3,810	P
Mean age (std)	76.9 (11.3)	77.2 (11.0)	75.6 (11.9)	75.4 (12.3)	74.2 (12.8)	0.000
Females	1,679 (48.8%)	1,730 (51.4%)	1,078 (49.9%)	2,016 (52.9%)	1,730 (51.1%)	0.008
Metropolitan resident regions of Calgary and Edmonton	66 (1.9%)	57 (1.7%)	10 (0.5%)	3,060 (90.4%)	3,510 (92.1%)	0.000
Comorbidity						
None	1,528 (44.4%)	1,347 (40.1%)	689 (31.9%)	1,216 (31.9%)	798 (23.6%)	0.000
One	1,288 (37.4%)	1,314 (39.1%)	840 (38.9%)	1,440 (37.8%)	1,275 (37.7%)	0.000
More than one	628 (18.2%)	702 (20.9%)	632 (29.2%)	1,154 (30.3%)	1,311 (38.7%)	0.000
Severity						
Anemia	271 (7.9%)	339 (10.1%)	399 (18.5%)	606 (15.9%)	859 (25.4%)	0.000
Electrolyte disturbance	134 (3.9%)	163 (4.8%)	203 (9.4%)	448 (11.8%)	590 (17.4%)	0.000
Coronary artery disease	845 (24.5%)	901 (26.8%)	845 (39.1%)	1,642 (43.1%)	1,757 (51.9%)	0.000
Hypertension	538 (15.6%)	593 (17.6%)	651 (30.1%)	1,194 (31.3%)	1,532 (45.3%)	0.000
Valvular heart disease	145 (4.2%)	157 (4.7%)	348 (16.1%)	944 (24.8%)	971 (28.7%)	0.000
Ventricular arrhythmia	33 (1.0%)	52 (1.5%)	153 (7.1%)	116 (3.0%)	207 (6.1%)	0.000
Hypotension and shock	21 (0.6%)	35 (1.0%)	42 (1.9%)	67 (1.8%)	129 (3.8%)	0.000
Severity score (mean, std)	5.5 (2.5)	5.7 (2.8)	6.3 (3.7)	6.0 (3.3)	6.5 (4.1)	0.000

Note than not all variables for each patient were available with percentages calculated on the actual number of patients with completed data for each variable.

Table 2 – Use of Health Services and Selected Procedures (Number and Percent) for Hospitalized Congestive Heart Failure in Alberta During the Period April 1, 1994 to March 31, 2000

	Rural hospitals Less than 200 cases n = 3,444	Rural hospitals 204 to 646 cases n = 3,363	Regional hospitals n = 2,161	Metropolitan hospitals without angiography n = 3,384	Metropolitan hospitals with angiography n = 3,810	P
Transferred to another acute care hospital	65 (1.9%)	77 (2.3%)	28 (1.3%)	23 (0.6%)	20 (0.6%)	0.000
Special care unit admission	224 (6.5%)	530 (15.8%)	731 (33.8%)	799 (21.0%)	687 (20.3%)	0.000
Cardiac catheterization – in-hospital	10 (0.3%)	13 (0.4%)	27 (1.2%)	208 (5.5%)	329 (9.7%)	0.000
Cardiac catheterization at one year from admission	167 (4.8%)	168 (5.0%)	171 (7.9%)	405 (10.6%)	527 (15.6%)	0.000
Percutaneous transluminal coronary Angioplasty / stent during year from admission	21 (0.6%)	22 (0.7%)	25 (1.2%)	47 (1.2%)	72 (2.1%)	0.000
Coronary artery bypass surgery during year from admission	31 (0.9%)	27 (0.8%)	36 (1.7%)	82 (2.2%)	70 (2.1%)	0.000

Note than not all variables for each patient were available with percentages calculated on the actual number of patients with completed data for each variable

Table 3 – Unadjusted Outcomes for Patients Hospitalized Congestive Heart Failure in Alberta During the Period April 1, 1994 to March 31, 2000

	Rural hospitals less than 200 cases n = 3,444 n [1] = 3,167 n [2] = 3,040	Rural hospitals 204 to 646 cases n = 3,363 n [1] = 3,067 n [2] = 2,958	Regional hospitals n = 2,161 n [1] = 1,938 n [2] = 1,882	Metropolitan hospitals without angiography n = 3,384 n [1] = 3,043 n [2] = 2,947	Metropolitan hospitals with angiography n = 3,810 n [1] = 3,453 n [2] = 3,338	P [3]
Length of stay (median, mean)	9.2 (22.1)	9.5 (19.7)	11.1 (15.8)	10.4 (12.4)	11.2 (12.4)	< 0.000
Total cost per hospital stay (dollars)	$3,941	$4,033	$4,548	$4,512	$5,672	< 0.000
180-day readmission[1]; n (%)	622 (19.6%)	653 (21.3%)	401 (20.7%)	588 (17.0%)	485 (15.9%)	< 0.000
In-hospital mortality; n (%)	277 (8.0%)	296 (8.8%)	223 (10.3%)	357 (9.4%)	341 (10.1%)	< 0.05
One-year mortality [1, 2] n (%)	693 (22.8%)	712 (24.1%)	435 (23.1%)	799 (23.9%)	713 (24.2%)	> 0.05

[1] Readmissions and one-year mortality exclude in-hospital deaths
[2] One-year mortality excludes patients not registered with the provincial health insurance plan at fiscal year-end
[3] Denotes least significant p in all pair comparisons per row

Table 4 – Adjusted Outcomes With Ninety-Five Percent Confidence Interval for Hospitalized Congestive Heart Failure in Alberta During the Period April 1, 1994 to March 31, 2000

	Rural hospitals less than 200 cases n.= 3,444 n [1]= 3,167 n [2]= 3,040	Rural hospitals 204 to 646 cases n = 3,363 n [1]= 3,067 n [2]= 2,958	Regional hospitals n = 2,161 n [1]= 1,938 n =[2] 1,882	Metropolitan hospitals without angiography n = 3,384 n [1]= 3,043 n [2]= 2,947	Metropolitan hospitals with angiography n = 3,810 n [1]= 3,453 n [2]= 3,338
Length of stay (median, mean)	9.4 (8.8, 9.9)	9.4 (8.8, 10.0)	10.4 (9.7, 11.1)	10.1 (9.6, 10.6)	9.8 (9.2, 10.4)
Total cost per hospital stay (dollars)	4,222 (4,118, 4,325)	4,112 (4,009, 4,215)	4,186 (4.058, 4,314)	4,313 (4,218, 4,409)	5,179 (5,072, 5,287)
180-days readmission [1]	19.8 (18.4, 21.1)	21.2 (19.9, 22.6)	20.3 (18.6, 22.0)	17.0 (15.7, 18.3)	15.9 (14.5, 17.3)
In-hospital mortality	9.7 (8.7, 10.7)	9.3 (8.3, 10.2)	9.0 (7.9, 10.0)	9.1 (8.3, 10.0)	9.0 (8.1, 9.9)
One-year mortality [1, 2]	22.7 (21.3, 24.2)	23.5 (22.0, 25.0)	22.1 (20.3, 23.9)	22.9 (21.6, 24.3)	22.9 (21.4, 24.3)

[1] Readmissions and one-year mortality exclude in-hospital deaths
[2] One-year mortality excludes patients not registered with the provincial health insurance plan at fiscal year-end

Table 5 – Unadjusted Outcomes for Patients Hospitalized Congestive Heart Failure in Alberta During the Period April 1, 1994 to March 31, 2000 in each of the Seventeen Alberta Regions (Where Hospitalization Occurred)

Service region	Total number of hospital admissions	Length of stay (median, mean)	Total cost per hospital stay (dollars)	180-days readmission; n (%)	In-hospital mortality; n (%)	*One-year mortality; n (%)
1	1,268	6 (9.9)	$4,284	210 (18.3%)	120 (9.5%)	219 (19.8%)
2	757	6 (11.0)	$4,275	149 (22.2%)	85 (11.2%)	165 (25.4%)
3	456	6 (9.2)	$4,585	70 (16.9%)	41 (9.0%)	110 (27.4%)
4	3,536	8 (11.0)	$4,931	558 (17.2%)	287 (8.1%)	742 (23.5%)
5	529	6 (10.2)	$4,186	91 (18.8%)	45 (8.5%)	102 (21.7%)
6	1,326	6 (11.8)	$4,438	269 (22.2%)	115 (8.7%)	287 (24.5%)
7	1,098	6 (9.1)	$3,840	202 (20.4%)	107 (9.7%)	234 (24.3%)
8	321	5 (9.9)	$4,196	55 (18.2%)	19 (5.9%)	83 (28.1%)
9	429	5 (10.3)	$4,046	99 (24.7%)	28 (6.5%)	94 (24.3%)
10	3,658	7 (10.6)	$5,179	515 (15.9%)	411(11.2%)	770 (24.6%)
11	551	6 (10.0)	$3,779	118 (23.8%)	55 (10.0%)	123 (26.0%)
12	1,053	5 (8.1)	$3,855	207 (21.4%)	85 (8.1%)	207 (22.3%)
13	591	5 (8.9)	$3,958	104 (19.2%)	50 (8.5%)	123 (23.8%)
14	227	4 (6.7)	$3,794	41 (20.0%)	22 (9.7%)	36 (18.4%)
15	166	4 (5.6)	$4,053	29 (18.4%)	8 (4.8%)	25 (16.8%)
16	113	7 (13.3)	$4,317	15 (14.6%)	10 (8.8%)	16 (16.2%)
17	83	5 (7.3)	$3,671	17 (22.1%)	6 (7.2%)	16 (21.3%)

Table 6 – Unadjusted Outcomes for Patients Hospitalized Congestive Heart Failure in Alberta During the Period April 1, 1994 to March 31, 2000 in Each of the Seventeen Alberta Regions (Where Patient Resided)

Resident region	Total number of hospital admissions	Length of stay (median, mean)	Total cost per hospital stay (dollars)	180-days readmission; n (%)	In-hospital mortality; n (%)	One-year mortality; n (%)
1	1,273	6 (9.9)	$4,302	211 (18.3%)	122 (9.6%)	219 (19.8%)
2	780	6 (10.9)	$4,318	154 (22.2%)	87 (11.2%)	167 (24.9%)
3	534	6 (9.4)	$4,802	82 (16.7%)	44 (8.2%)	121 (25.4%)
4	3,373	8 (11.0)	$4,818	527 (17.0%)	273 (8.1%)	718 (23.8%)
5	539	6 (10.8)	$4,505	101 (20.5%)	46 (8.5%)	100 (20.9%)
6	1,397	6 (11.5)	$4,512	280 (22.0%)	122 (8.7%)	294 (23.8%)
7	1,135	6 (9.0)	$3,968	204 (19.9%)	111 (9.8%)	246 (24.8%)
8	433	5 (10.0)	$4,246	75 (18.6%)	30 (6.9%)	102 (26.0%)
9	373	5 (11.0)	$4,241	87 (24.9%)	23 (6.2%)	78 (23.1%)
10	3,330	7 (10.6)	$5,093	469 (16.0%)	390(11.7%)	722 (25.4%)
11	640	6 (10.0)	$4,163	126 (21.8%)	62 (9.7%)	141 (25.8%)
12	1,155	5 (8.3)	$3,997	224 (21.0%)	88 (7.6%)	224 (21.9%)
13	586	5 (9.1)	$3,998	106 (19.8%)	50 (8.5%)	120 (23.4%)
14	220	4 (6.8)	$3,852	35 (17.7%)	22 (10.0%)	37 (19.7%)
15	184	4 (5.5)	$4,049	35 (19.9%)	8 (4.3%)	29 (17.5%)
16	120	7 (13.1)	$4,354	16 (14.5%)	10 (8.3%)	17 (16.0%)
17	90	5 (7.3)	$3,720	17 (20.2%)	6 (6.7%)	17 (20.7%)

BIOGRAPHIES

Yan Jin, M.A.

B.Sc. of Computer Sciences, Anhui University, China

M.A. of Demography, University of Alberta, Canada

Project Consultant, Research and Evidence, Alberta Health and Wellness

As a demographer, Yan Jin is interested in applying demographic and statistical techniques in health field, particularly in population health and health service utilization. He has taught demographic techniques at the University of Alberta.

Contact Information:

Yan Jin, M.A.
Research and Evidence
Health Accountability
Alberta Health and Wellness
22 Floor, 10025 Jasper Avenue
Edmonton, Alberta
T5J 1S6
Phone: (780) 415-0210
Fax: (780) 422-2880
E-mail: yan.jin@gov.ab.ca

Hude Quan, M.D., Ph.D.

Ph.D. of Epidemiology, University of Calgary

Diploma of Maternal and Child Health, University of London

Population and Economic Training Program, Asia and Pacific Development Centre of the United Nations, Malaysia

Master of Public Health, Harbin Medical University, China

M.D., Harbin Medical University, China

Consultant for the Alberta Centre for Health Services Utilization Research and the Department of Community Health Sciences of the University of Calgary

Dr. Hude Quan served as Deputy Director of the teaching and research committee, The Dept. of Social Medicine, Harbin Medical University, China, and as Epidemiologist of the National Prevention of Rickets Co-operative, Research Program of China. He was also a lecturer in Public Health (undergraduate and graduate courses) at Harbin Medical University, China. Since 1994, he as worked on research at the Department of Community Health Sciences, University of Calgary. Dr. Quan has published numerous reports and abstracts. His interests are evaluation of health service outcome and alternative medicine, and psychiatric epidemiology.

Contact Information:

Hude Quan, M.D., Ph.D.
Department of Community Health Services
University of Calgary
3330 Hospital Drive NW
Calgary, Alberta
T2N 4N1
Phone: (403) 220-2865
Fax: (403) 270-7307
E-mail: hquan@ucalgary.ca

Bibiana Cujec, M.D., FRCPC

Dr. Cujec is currently an Associate Professor of Medicine in the Division of Cardiology at the University of Alberta and a staff cardiologist at the University of Alberta Hospital.

Dr. Cujec's clinical interests include management of patients with heart failure and echocardiography (cardiac ultrasound for diagnosis of heart disease).

Contact information:

Bibiana Cujec, M.D., FRCPC
University of Alberta
2C2.39 Walter Mackenzie Centre
Edmonton, Alberta
T6G 2B7
Phone: (780) 407-3601
Fax: (780) 407-6452
E-mail: bibiana.cujec@ualberta.ca

David Johnson, M.D., S.M., M.B.A.

M.D., McGill University

S.M., Harvard University

M.B.A., University of Saskatchewan

As a physician, Dr. David Johnson's clinical practice is affected by the health care system. Dr. Johnson is interested in understanding and promoting the use of information in directing health policy formation and decision-making by the managers of the health care system.

Contact Information:

David Johnson, M.D., S.M., M.B.A.
368 O'Connor Close
Edmonton, Alberta
T6R 1L4
E-mail: cujecjohnson@shaw.ca